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ASTROMETRIC OBSERVATIONS OF COMETS AND ASTEROIDS
AND SUBSEQUENT ORBITAL INVESTIGATIONS

Grant NGR 09-015-212

Semiannual Progress Report No. 16

For the period May 1 to October 31, 1981

Principal Investigators

Dr. Richard E. McCrosky

Dr. Brian G. Marsden

November 1981



Prepared for

National Aeronautics and Space Administration
Washington, D. C. 20546

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

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1. Personnel

R. E. McCrosky, Principal Investigator	No cost
B. G. Marsden, Coinvestigator	No cost
C. M. Bardwell, Data Reduction	No cost
G. Schwartz, Observer	No cost
D. W. E. Green, Observer and Measurer	No cost
C.-Y. Shao, Data Reduction and Observer	Full time

2. Observing Program

The 155-cm reflector was used for observations of comets and minor planets on 50 nights during the semester. Of the total of 248 observations, 42 referred to comets, 78 to numbered minor planets and 128 to unnumbered minor planets. The record number of accurate positions measured and reduced, 351, included 131 results from plates obtained previously. The outcome is summarized in the two tables: table 1 lists the 351 reductions, while table 2, gratifyingly small, lists the other 28 observations made during the semester that remain to be measured.

The observing was done by McCrosky, Shao, Schwartz and Green, the measurements and reductions by McCrosky, Shao and Green, the checking of the results and the selection of objects to be observed by Marsden and Bardwell. The

reductions were mainly done on the NOVA computer at the Agassiz observing station, the remaining computations on the VAX computer in Cambridge.

3. Results of Special Interest

Two short-period comets, P/Slaughter-Burnham (1981i) and P/Swift-Gehrels (1981j), were recovered. The announcement of these recoveries on consecutive IAU Circulars published five days apart provides an excellent illustration of the way such announcements should be made. In the past year or so, a number of observers with access to large telescopes have been attempting to pick up returning periodic comets (P/Halley included), but it has not always been clear that the results were successful. In the case of these two recent Agassiz recoveries the reports each included accurate measurements on as many as three nights, and there was thus absolutely no doubt that the claims were correct.

Other significant cometary observations included early post-recovery observations of P/Gehrels 2 (1981f) and P/Kearns-Kwee (1981h), a trio of useful observations of comet Bradfield (1980t) at great distance from the sun, and observations of the new periodic comets Bus (1981b) and Howell (1981k) that will help refine the periods of these objects.

In the area of minor planets, we have made the only observations of the unique object (2060) Chiron since shortly after its discovery four years ago, and we got on to the new Amor objects 1981 QA and 1981 QB soon after they were discovered.

Minor planets newly numbered entirely as a result of our observations

were: (2385) 1969 VW, (2400) 1972 KJ, (2427) 1978 YQ7, (2435) 4578 P-L, (2453) A921 SA, (2457) 1975 TU2, (2463) 1934 FF, (2475) 1972 TF2, (2482) 1980 CO (an Agassiz discovery), (2484) 1928 TK, (2485) 1932 BH, (2491) 1977 CB, (2493) 1978 XC (an Agassiz discovery) and (2495) 7071 P-L. (2395) 1977 FA was a new Agassiz discovery.

4. Orbital Investigations

These have continued much as usual. Special computations were done with regard to the close approach of (2100) Ra-Shalom.

5. Financial

No unusual expenditures occurred during this period. The program continues to operate within the original budget.

6. Publications

Observations from Agassiz plates are included in the following publications issued during this half year: Minor Planet Circ. Nos. 5990-5991, 6069-6070, 6076, 6146-6147, 6162, 6225-6227, 6267-6269, 6350, 6410-6411, 6429-6431, 6435-6436 and 6457-6458; IAU Circ. Nos. 3621-3622, 3625, 3630, 3634, 3636 and 3645.

Orbital/and or ephemeris computations are on Minor Planet Circ. Nos. 6043-6055, 6061-6064, 6098-6099, 6101-6144, 6188-6190, 6193-6207, 6210-6220, 6285-6287, 6290-6301, 6307-6344, 6413-6414, 6416-6421, 6422-6424, 6463-6464 and 6468-6480; IAU Circ. Nos. 3601, 3606-3608, 3618, 3623, 3625, 3627, 3630, 3633-3636, 3638-3640 and 3645.

Table 1

Positional measurements

The successive columns give the object's designation (/ = comet, * = new discovery), the UT date and time, the right ascension (in hours, minutes and seconds) and declination (in degrees, minutes and seconds) — equinox 1950.0.

/1974 II	1978 04	13.04659	05 13	50.36	+29 09	35.8
/1974 II	1978 11	01.30564	07 32	12.12	+27 00	54.8
/1976 III	1978 10	28.25569	04 47	07.57	+21 47	14.2
/1976 III	1981 01	06.32492	09 51	36.84	+25 34	20.4
/1976 III	1981 02	04.32880	09 33	57.49	+27 56	42.0
/1977 X	1978 08	09.30845	23 21	05.87	+01 02	07.1
/1977 X	1978 08	27.26255	22 56	36.21	-00 55	11.1
/1977 X	1978 09	05.25112	22 43	59.04	-01 58	54.9
/1977 X	1978 09	26.19975	22 16	44.79	-04 21	45.2
/1977 X	1978 10	31.02172	21 46	28.65	-07 08	50.0
/1977 X	1978 11	01.02858	21 45	55.40	-07 12	01.6
/1978 II	1978 09	27.23312	23 51	50.31	-18 08	09.2
/1978 XXIV	1978 03	07.39529	15 00	15.64	-09 33	13.5
/1979j	1981 03	12.33888	13 01	51.27	+07 03	57.6
/1979j	1981 04	08.29602	12 44	10.57	+09 43	08.3
/1979k	1980 12	05.36524	06 31	39.50	+19 14	48.8
/1980b	1981 02	10.36119	12 36	15.40	-01 58	13.3
/1980b	1981 05	23.13544	12 07	23.67	+01 15	28.0
/1980b	1981 06	06.14887	12 08	58.49	+01 00	14.0
/1980f	1980 09	09.15631	22 10	47.17	-07 43	57.8
/1980f	1981 01	31.01521	01 09	41.74	+03 13	46.3
/1980f	1981 03	02.01661	02 14	21.51	+09 13	08.2
/1980g	1981 03	02.11111	06 45	48.49	+44 06	27.9
/1980g	1981 04	04.06542	07 52	27.82	+40 53	08.2
/1980i	1981 01	30.98852	01 03	21.92	-04 46	18.0
/1980j	1981 01	31.99483	00 32	53.95	+07 36	40.4
/1980q	1981 04	10.35159	15 14	05.12	+22 31	52.9
/1980q	1981 06	03.15944	12 39	23.29	+06 47	03.4
/1980t	1981 06	29.29641	22 01	20.20	+16 31	17.2
/1980t	1981 07	07.29499	21 50	12.78	+16 04	52.8
/1980t	1981 07	28.25197	21 17	49.75	+13 45	37.0
/1980t	1981 08	27.16534	20 36	09.01	+08 26	08.8
/1980u	1980 10	09.08054	19 13	58.72	+37 45	02.8
/1980u	1980 10	27.97561	18 49	24.81	+35 50	04.7
/1981a	1981 06	06.09318	10 20	49.29	+20 39	30.5
/1981b	1981 03	11.20264	11 48	37.00	+00 35	16.8
/1981b	1981 05	23.08895	11 39	24.45	+03 24	06.6
/1981b	1981 05	24.11951	11 40	11.23	+03 20	03.2
/1981b	1981 06	06.11803	11 51	56.23	+02 14	36.8
/1981b	1981 06	27.09139	12 17	10.94	-00 16	34.0
/1981d	1981 05	03.19171	14 58	02.39	-05 37	02.8
/1981d	1981 05	08.26921	14 36	02.61	-04 43	18.7
/1981d	1981 05	27.13154	13 19	54.43	-01 44	23.2
/1981d	1981 06	24.09927	12 11	24.83	+00 04	26.3
/1981f	1981 08	01.27949	01 41	21.43	+14 48	10.3
/1981f	1981 06	27.35874	02 01	48.95	+16 10	44.4
/1981f	1981 09	25.34654	02 07	08.50	+15 36	00.6
/1981h	1981 08	01.31654	04 15	07.48	+29 20	35.6
/1981h	1981 08	29.35741	05 09	58.49	+31 46	24.0
/1981h	1981 09	25.37356	05 58	27.83	+33 08	12.9
/1981i	1981 07	09.28863	00 50	42.84	+06 32	07.5
/1981i	1981 07	10.30329	00 51	38.22	+06 40	55.2
/1981i	1981 07	28.29563	01 05	47.44	+09 07	19.6
/1981i	1981 08	26.28417	01 16	44.88	+12 14	27.2
/1981i	1981 09	25.31454	01 08	48.62	+13 54	56.9
/1981j	1981 07	11.28627	22 40	08.05	-07 38	49.3
/1981j	1981 07	31.26675	22 43	50.46	-04 41	57.5
/1981j	1981 08	01.23275	22 43	44.48	-04 33	17.4
/1981j	1981 08	02.28005	22 43	35.89	-04 23	51.7

/1981J	1981 08	26.19737	22 31	35.06	-00 43	42.8
/1981J	1981 09	25.20950	22 05	03.25	+03 53	57.4
/1981K	1981 09	05.23556	00 33	08.82	-08 08	54.2
/1981K	1981 09	07.20690	00 31	39.18	-08 18	41.6
/1981K	1981 09	29.21800	00 12	22.75	-09 40	47.6
50	1981 05	09.17860	14 37	26.56	-12 04	24.6
431	1981 02	01.03595	04 04	01.19	+19 25	49.3
574	1978 04	09.26742	13 10	03.66	-14 16	33.4
682	1981 01	31.15561	07 44	27.13	+05 27	17.9
682	1981 03	04.08711	07 26	55.69	+08 17	17.9
863	1981 06	30.09733	13 50	48.36	+18 54	44.7
1162	1981 08	27.30468	00 01	47.87	-01 46	24.9
1176	1978 09	29.15343	22 03	00.95	-01 39	32.5
1187	1980 09	19.16414	22 17	03.82	-04 48	59.4
1537	1981 02	28.34109	14 16	21.35	-15 41	46.1
1537	1981 03	04.38977	14 15	41.94	-15 38	25.0
1737	1981 09	21.18681	22 50	07.31	-02 16	10.6
1758	1978 04	07.07005	07 54	51.64	+25 23	36.7
1824	1981 04	01.15139	11 33	05.98	+03 48	01.9
1911	1981 09	29.35088	03 05	33.24	+19 26	13.0
1971	1981 09	25.26448	00 36	27.29	+17 27	28.9
2047	1978 04	10.35161	15 56	57.34	-24 50	48.1
2060	1981 08	29.32840	03 22	39.14	+16 00	36.1
2060	1981 09	05.30634	03 22	32.36	+15 58	28.2
2086	1981 03	04.04131	07 23	50.71	+31 51	48.7
2100	1981 09	05.13128	20 40	12.51	+03 16	15.4
2115	1978 04	15.29436	14 14	26.25	-20 21	04.0
2221	1980 09	12.10090	21 31	41.64	+10 45	27.6
2228	1981 05	09.17860	14 37	13.04	-12 29	43.9
2274	1978 09	28.31733	02 50	53.99	+18 43	10.5
2304	1980 09	09.26564	02 00	55.65	+11 50	54.1
2306	1980 09	09.29123	02 07	16.61	+16 51	13.0
2307	1979 06	01.16385	17 30	03.03	-21 51	49.5
2307	1980 09	04.23553	23 10	31.22	+06 57	54.5
2311	1980 09	09.12833	22 01	17.14	-11 21	13.0
2314	1977 11	12.12332	03 01	33.32	+19 53	41.6
2326	1980 12	11.14704	03 18	53.80	-05 58	22.2
2331	1980 12	04.15142	02 50	57.50	+18 31	30.3
2332	1980 12	04.07169	02 32	49.86	+10 23	01.7
2347	1981 02	06.12397	05 51	58.12	+25 48	31.0
2349	1981 02	10.00657	03 54	44.82	+03 58	01.8
2352	1980 09	04.31247	00 21	53.20	+20 59	57.6
2353	1980 12	04.18804	03 27	23.64	+23 17	01.0
2370	1981 03	04.04131	07 23	40.19	+31 51	53.5
2374	1981 01	31.08265	03 48	22.84	+38 56	50.2
2377	1981 05	09.11105	12 00	52.64	-01 28	02.2
2385	1981 04	08.17744	10 30	37.74	+11 17	31.1
2386	1981 02	06.19108	07 43	23.85	+33 03	59.0
2386	1981 03	27.07428	07 30	10.88	+30 41	46.7
2387	1981 05	09.17860	14 36	47.41	-12 20	40.3
2394	1981 03	12.24079	10 24	45.67	+11 15	26.9
2400	1981 03	11.16123	09 30	14.92	+09 06	56.8
2400	1981 04	07.16322	09 22	22.18	+11 15	54.5
2400	1981 05	03.11329	09 28	41.37	+12 04	36.7
2409	1981 03	02.23061	10 37	19.68	+10 34	01.7
2409	1981 04	08.12005	10 11	01.76	+13 29	58.6
2423	1981 04	08.26751	12 29	58.81	-09 54	05.5
2425	1981 05	09.20029	14 48	48.43	-14 04	19.0
2425	1981 05	24.20512	14 35	58.25	-14 02	17.2
2426	1981 06	01.22738	15 41	38.70	-18 19	21.1
2426	1981 06	27.16848	15 28	23.06	-16 12	14.2

2426	1981 06	28.16069	15 28	11.11	-16 08	57.6
2427	1981 01	03.01091	00 50	37.12	+06 07	56.0
2430	1977 11	12.12332	03 01	36.39	+20 10	57.2
2431	1981 04	08.08463	09 55	38.16	+11 45	23.0
2435	1980 12	05.28676	06 08	20.73	+16 30	22.1
2436	1981 06	30.22359	17 38	35.22	-19 55	10.5
2441	1981 01	31.18801	07 50	31.63	+19 07	32.0
2444	1981 07	09.17797	19 24	30.67	-20 56	42.5
2444	1981 08	03.13738	19 01	02.97	-19 53	55.4
2447	1981 07	09.21656	22 02	28.60	-07 12	43.2
2447	1981 08	27.22229	21 45	01.57	-14 21	06.5
2447	1981 09	21.14102	21 35	50.19	-18 13	21.5
2448	1981 06	05.26750	20 37	42.32	-10 01	26.0
2448	1981 06	27.27877	20 31	28.85	-11 37	32.5
2448	1981 08	02.19407	20 04	10.00	-16 24	37.7
2449	1980 02	12.03728	04 44	35.78	-09 42	12.0
2449	1981 05	09.32641	19 00	47.17	+21 00	18.9
2449	1981 06	01.32862	19 13	03.22	+29 17	58.8
2449	1981 07	28.11292	18 45	20.55	+28 36	24.5
2449	1981 07	28.16424	18 45	19.34	+28 35	15.8
2449	1981 08	22.11256	18 48	02.68	+17 02	48.1
2453	1981 02	28.03038	07 55	37.20	+33 21	29.8
2453	1981 03	27.11177	07 53	09.33	+31 34	07.4
2454	1981 06	02.16638	14 35	25.22	-17 05	14.7
2454	1981 07	01.12148	14 29	11.71	-15 05	06.3
2457	1980 12	04.29899	06 02	50.47	+15 29	07.9
2457	1981 01	03.24133	05 34	27.41	+15 57	30.1
2458	1981 06	28.13429	14 02	45.72	-09 48	11.3
2458	1981 06	29.09354	14 02	54.21	-09 49	48.7
2459	1981 06	27.24649	21 56	13.86	+01 16	08.2
2459	1981 09	29.12567	21 38	13.43	-02 04	59.2
2462	1981 04	03.34142	13 08	35.84	-01 15	41.5
2462	1981 05	08.21525	12 43	38.01	+00 33	35.5
2462	1981 06	05.14956	12 45	22.78	-00 43	44.8
2463	1981 05	09.22970	16 19	02.75	-03 49	10.9
2463	1981 05	24.22823	16 06	32.50	-02 33	31.9
2468	1980 12	04.24339	05 05	46.39	+16 52	36.2
2468	1981 01	03.13788	04 37	09.58	+15 39	49.7
2468	1981 02	04.11862	04 31	51.10	+15 56	35.2
2469	1981 04	07.33302	15 30	27.86	-05 52	11.9
2469	1981 05	04.25646	15 15	16.51	-03 27	01.2
2469	1981 06	01.18263	14 55	28.83	-02 06	31.1
2469	1981 06	24.13610	14 47	02.37	-02 33	26.3
2470	1981 09	29.31601	02 35	34.30	+11 36	07.9
2475	1981 06	24.20721	16 40	41.00	-12 34	57.7
2475	1981 06	28.21481	16 38	02.40	-12 29	03.8
2476	1981 04	03.36494	14 07	37.30	+00 53	30.9
2476	1981 05	04.22894	13 44	04.80	+02 21	23.9
2476	1981 05	08.24899	13 41	13.00	+02 24	55.1
2477	1981 06	29.27005	21 50	43.67	-03 07	26.4
2477	1981 06	30.25499	21 50	48.32	-03 03	54.9
2477	1981 08	03.19219	21 37	40.41	-03 10	55.1
2477	1981 09	05.15692	21 13	33.94	-06 27	50.7
2480	1981 04	03.31691	12 38	32.36	-01 58	30.2
2481	1981 08	27.30468	00 03	07.28	-01 55	49.8
2481	1981 09	25.23124	23 42	11.26	-03 15	33.3
2482	1981 05	09.25913	16 19	18.62	-18 16	17.2
2482	1981 05	25.24442	16 06	04.09	-17 49	23.3
2482	1981 06	27.19404	15 42	40.57	-17 12	46.7
2482	1981 07	01.18407	15 41	04.67	-17 12	34.2
2484	1981 05	09.15160	14 17	42.13	-13 11	41.1

2484		1981 06	30.09416	13 54	19.29	-10 56	31.8
2484		1981 07	01.09090	13 54	32.80	-10 57	47.0
2485		1981 08	29.29600	01 07	48.96	+02 59	00.1
2485		1981 09	30.29635	00 51	03.24	+00 48	21.0
2488		1981 01	31.39477	10 37	55.36	+20 05	55.9
2489		1981 08	27.32809	00 05	30.30	-02 03	17.6
2489		1981 09	30.21946	23 41	30.40	-04 31	08.2
2492		1981 02	01.37834	10 56	03.04	+07 43	02.0
2492		1981 02	28.22559	10 37	58.66	+09 31	05.2
2493		1981 05	03.28487	15 49	12.17	-13 55	30.0
2493		1981 05	25.21101	15 31	14.85	-11 56	57.9
2493		1981 06	24.14378	15 12	19.54	-10 14	35.5
2495		1981 08	27.06976	18 42	33.96	+13 26	46.1
2495		1981 09	30.02184	19 17	17.65	+02 59	26.0
1934	RR	1981 06	01.25441	15 49	54.25	-14 51	08.2
1940	GN	1981 01	03.16927	04 37	43.10	+22 39	35.4
1940	GN	1981 02	01.07307	04 26	27.16	+23 19	02.5
1943	EO	1981 09	29.26904	00 56	35.38	+04 34	02.9
1950	EL	1981 10	06.14380	01 23	18.77	+09 00	34.8
1950	FC	1981 09	25.26448	00 38	37.46	+17 55	16.8
1950	FC	1981 09	29.24147	00 35	01.06	+17 42	59.2
1964	TA1	1981 08	26.24687	22 56	50.12	-08 14	09.7
1964	TA1	1981 09	30.19208	22 29	42.36	-10 12	13.6
1964	TX1	1981 10	06.19060	02 14	32.14	+10 04	55.8
1964	TC2	1981 02	28.31201	12 27	08.84	-04 39	31.4
1964	VY	1981 10	04.14582	01 05	38.70	+04 49	04.7
1966	FD	1981 02	04.29931	08 33	19.22	+13 03	48.8
1966	PD	1981 03	04.12308	08 10	45.02	+14 10	39.4
1966	PD	1981 04	08.05059	08 14	17.19	+14 26	45.6
1968	SR	1980 12	05.33538	06 23	46.94	+24 23	50.2
1968	SR	1981 03	02.08132	05 43	52.82	+24 59	51.7
1972	ID1	1980 09	16.29543	02 09	00.14	-09 56	59.0
1972	LD1	1981 01	06.03317	01 24	09.33	-08 21	32.9
1973	SQ2	1981 01	09.14317	05 01	09.72	+26 53	19.6
1974	FG	1981 04	08.20609	11 53	46.73	-02 54	28.4
1974	FG	1981 05	02.15090	11 44	10.57	+00 07	40.5
1974	XX	1981 03	11.06397	07 54	25.17	+36 12	03.4
1974	XX	1981 03	27.04507	07 57	59.53	+35 39	59.0
1975	EE3	1981 08	26.09399	20 20	58.71	+09 21	39.9
1975	FE3	1981 09	25.09809	20 14	14.98	+00 10	39.7
1976	EC	1976 03	30.10308	09 10	26.93	+15 08	08.1
1976	GX2	1981 06	29.21024	18 12	12.71	-03 28	40.1
1976	GX2	1981 06	30.18634	16 11	20.92	-03 29	20.8
1976	GX2	1981 07	31.17748	17 52	04.46	-05 10	18.4
1976	GJ3	1981 03	04.32556	10 47	44.34	+30 37	57.4
1976	GJ3	1981 03	27.16806	10 29	08.99	+30 13	10.7
1976	GV	1981 02	05.99424	03 31	21.43	+21 23	51.5
1976	GG1	1981 09	29.19502	23 51	05.14	-01 55	19.3
1976	GG1	1981 09	30.24638	23 50	18.16	-02 01	01.5
1976	GG1	1981 10	01.12479	23 49	39.59	-02 05	48.4
1976	GG1	1981 10	06.08873	23 46	08.22	-02 31	41.6
1976	UB	1981 08	01.19222	21 31	57.18	-14 33	13.3
1976	UB	1981 08	08.16020	21 26	42.75	-14 58	30.5
1976	UP20	1981 08	26.13872	20 19	39.26	-13 02	35.7
1976	UP20	1981 09	29.08740	20 13	09.02	-15 34	47.6
1976	YX1	1981 09	29.29105	01 02	34.41	+06 42	30.2
1977	ET1	1981 06	27.13319	15 23	55.10	-09 51	05.0
1977	ET1	1981 06	28.18323	15 23	40.91	-09 51	24.1
1977	NR	1981 09	29.35088	03 06	38.87	+19 23	09.4
1977	PW1	1981 06	05.11723	14 35	30.44	-26 27	09.3
1977	PZ1	1981 08	08.24263	22 01	05.57	-08 47	22.8

1977	PZ1	1981	09	05.17968	21	36	53.45	-08	59	50.6
1977	FZ1	1981	09	30.11883	21	29	15.59	-08	57	02.9
1977	PZ1	1981	10	01.03473	21	29	21.62	-08	55	59.5
1977	QL2	1981	08	29.20304	23	08	14.20	+00	20	18.1
1977	QL2	1981	09	21.18681	22	56	17.55	-02	19	50.9
1977	GN3	1981	06	05.19550	15	46	22.45	-21	50	11.1
1977	HR	1981	03	04.25546	08	35	13.45	+35	29	21.3
1978	GR	1981	05	08.29656	16	09	11.54	+30	08	13.1
1978	GR	1981	06	02.22800	15	43	57.69	+31	29	18.6
1978	GR	1981	06	30.18692	15	27	28.43	+26	38	58.7
1978	NC3	1981	02	10.23436	09	01	47.56	+03	52	31.1
1978	NC3	1981	03	11.09564	08	44	20.44	+06	29	02.5
1978	PP2	1981	03	27.19007	11	08	00.32	+05	42	14.7
1978	PP2	1981	05	08.10488	10	56	34.38	+06	33	03.9
1978	PP2	1981	05	09.07552	10	56	46.46	+06	31	28.2
1978	PP3	1981	04	04.35720	12	35	35.49	-00	14	29.4
1978	RT	1981	01	31.29973	09	15	36.26	+23	48	47.4
1978	RT	1981	02	28.12461	08	53	43.06	+24	46	33.4
1978	ROI	1981	08	26.16584	22	18	56.46	-09	24	41.1
1978	SF	1981	08	02.24736	21	31	10.03	-15	47	55.8
1978	SP	1981	08	27.19841	21	10	28.03	-16	57	43.8
1978	SY2	1981	08	03.16564	20	31	25.35	-21	45	14.1
1978	V05	1981	06	03.24657	16	19	56.29	-21	08	51.4
1978	V05	1981	06	05.21773	16	18	15.64	-21	06	57.0
1978	VJ7	1981	06	03.19490	15	19	10.70	-17	28	00.5
1978	VJ7	1981	06	05.17434	15	17	53.78	-17	22	58.8
1978	DE	1981	08	27.27635	22	11	19.19	-20	24	59.3
1979	DE	1981	09	30.15444	21	50	33.57	-23	45	09.3
1979	DK	1981	08	29.22829	00	06	30.76	+12	20	43.0
1979	DK	1981	09	30.27400	23	42	00.54	+10	26	40.9
1979	MF4	1981	02	01.18963	06	37	16.14	+20	49	36.4
1979	MR4	1981	03	02.04743	04	50	18.33	+17	27	38.6
1979	MS8	1981	02	01.03595	04	03	16.78	+19	23	44.7
1979	OE	1981	02	10.04321	05	02	20.02	+23	39	52.0
1980	CF	1981	06	27.21822	16	39	30.72	-15	51	33.5
1980	EC	1981	09	05.08128	19	27	01.24	-12	00	26.3
1980	GC	1981	06	28.24024	16	54	16.50	+04	20	35.8
1980	GC	1981	08	02.16326	16	44	45.34	+02	39	36.9
1980	GC	1981	08	03.09977	16	44	41.63	+02	35	47.6
1980	KJ	1981	10	04.19418	01	08	52.62	+13	11	50.8
1980	KN	1981	10	01.08289	21	51	58.66	-16	11	20.3
1980	LA	1980	09	11.08640	19	19	26.49	+15	24	55.4
1980	LD	1981	10	04.16863	01	23	05.31	-08	47	52.5
1980	ES	1980	10	06.05731	20	26	40.41	-07	01	33.3
1980	PV	1981	10	06.22287	02	21	53.54	+26	35	44.7
1980	UA	1981	01	31.04821	02	06	13.41	+11	23	02.2
1980	VX	1981	02	04.03523	03	25	41.44	+18	36	09.1
1980	XA	1981	02	03.99255	03	38	18.09	+25	23	05.9
1981	RQ	* 1981	01	31.15561	07	44	43.24	+05	33	20.0
1981	CW	1981	06	03.09855	11	32	22.40	+10	21	24.6
1981	CC1	* 1981	02	01.29274	09	32	37.06	+16	45	08.3
1981	EB2	* 1981	03	04.35720	12	35	34.87	-00	29	07.5
1981	FD	1981	04	23.13961	12	05	12.51	-05	24	52.1
1981	FD	1981	05	08.17444	12	08	52.68	-01	26	07.9
1981	FD	1981	06	01.09735	12	26	32.84	-03	59	40.4
1981	FO	1981	04	01.15139	11	33	31.54	+03	08	12.0
1981	GK1	* 1981	04	03.31691	12	38	39.50	-02	03	51.9
1981	GL1	* 1981	04	07.33302	15	30	41.00	-06	04	24.3
1981	GM1	* 1981	04	01.15139	11	34	08.49	+03	40	42.4
1981	GN1	* 1981	04	01.15139	11	34	35.21	+03	31	03.2
1981	GO1	* 1981	04	01.15139	11	33	49.87	+03	47	20.3

1981	IM	*	1981	06	03.22119	15	45	49.33	-20	48	38.7
1981	PA		1981	07	31.26675	22	46	00.56	-04	40	53.8
1981	PA	*	1981	08	01.23275	22	45	13.28	-04	33	35.7
1981	PA		1981	08	02.28005	22	44	19.28	-04	25	41.3
1981	PA		1981	08	08.18714	22	38	33.56	-03	42	08.5
1981	PA		1981	08	22.13855	22	20	48.73	-02	06	43.7
1981	PA		1981	08	29.17697	22	10	22.61	-01	23	24.1
1981	PA		1981	09	25.14815	21	33	40.42	+00	51	40.7
1981	PF	*	1981	08	08.24263	22	01	33.36	-08	43	22.4
1981	PF		1981	08	29.14972	21	54	00.58	-15	14	48.0
1981	QA		1981	08	24.06192	20	20	20.20	+02	44	19.3
1981	QA		1981	08	34.17383	20	20	40.17	+02	40	45.2
1981	QA		1981	08	26.06258	20	26	55.09	+01	34	37.7
1981	QA		1981	08	27.12214	20	30	29.21	+01	51	57.3
1981	QA		1981	08	29.12097	20	37	23.42	-00	15	02.1
1981	QA		1981	09	07.16667	21	10	25.60	-05	38	34.6
1981	QA		1981	09	21.16608	22	01	50.85	-12	12	43.0
1981	QB		1981	09	05.10424	21	29	56.28	-19	57	44.1
1981	QB		1981	09	07.14476	21	27	37.58	-23	29	46.9
1981	QK1	*	1981	08	26.24687	22	57	26.10	-08	24	55.2
1981	GL1	*	1981	08	27.24649	21	56	01.20	+01	31	42.0
1981	RU	*	1981	09	05.26603	00	58	04.50	+09	57	34.8
1981	SB	*	1981	09	29.19502	23	51	31.77	-01	38	52.6
1981	SR		1981	09	30.24638	23	50	49.19	-01	48	31.4
1981	SB		1981	10	01.12479	23	50	14.78	-01	56	29.0
1981	SR		1981	10	06.08873	23	47	14.59	-02	38	56.4
1981	SC	*	1981	09	29.19502	23	52	32.77	-01	47	01.7
1981	SC		1981	09	30.24638	23	51	26.89	-01	47	28.6
1981	SC		1981	10	01.12479	23	50	31.99	-01	47	46.1
1981	SD	*	1981	09	30.24638	23	50	47.94	-01	46	16.4
1981	SD		1981	10	01.12479	23	50	08.91	-01	52	41.5
1981	SD		1981	10	06.08873	23	46	41.86	-02	27	02.2
1981	SE		1981	09	29.19502	23	52	12.12	-01	46	01.6
1981	SE	*	1981	09	30.24638	23	51	17.58	-01	52	36.7
1981	SE		1981	10	01.12479	23	50	32.84	-01	57	52.9
1981	SE		1981	10	06.08873	23	46	28.64	+02	26	58.2
1981	SU	*	1981	09	25.26448	00	38	48.68	+17	46	41.1
1981	SU		1981	09	29.24147	00	35	27.80	+17	37	15.7
1981	SV	*	1981	09	30.29635	00	51	39.61	+00	51	56.1
1981	TA	*	1981	10	01.12479	23	50	19.67	-02	08	52.4
1981	TR		1981	09	30.24638	23	51	49.41	-01	55	38.0
1981	TB	*	1981	10	01.12479	23	51	08.60	-01	59	22.0
1981	TC	*	1981	10	04.14582	01	04	06.67	+04	58	47.3
1981	TD	*	1981	10	04.14582	01	04	41.53	+04	47	41.1
1981	TE	*	1981	10	04.14582	01	05	20.24	+04	46	46.8
2605	P-L		1981	06	01.15447	13	28	44.24	-12	16	11.6
4021	P-L		1981	04	03.19637	11	32	56.20	+00	57	00.8
4579	P-L		1981	09	30.32431	00	59	48.33	+03	34	30.4

Table 2

Unmeasured observations

/1974 JI	1981 04 23
/1974 II	1981 05 03
/1974 III	1981 05 08
/1981f	1981 10 31
/1981h	1981 10 31
/1981i	1981 10 31
883	1981 10 31
2100	1981 07 28
2475	1981 06 01
2480	1981 05 24
2480	1981 05 25
2495	1981 10 24
1974 FG	1981 05 23
1976 WR1	1981 10 25
1977 ET1	1981 06 02
1977 FA2	1981 10 31
1977 OR2	1981 10 31
1978 HJ5	1981 06 29
1978 VJ	1981 06 05
1979 DK	1981 10 25
1980 CK	1981 06 05
1980 CK	1981 06 28
1980 CK	1981 08 01
1980 CH	1981 10 25
1981 PA	1981 06 05
1981 FA	1981 10 29
1981 SB	1981 10 31
1981 UC	1981 10 25